THE EFFECTS OF ELEVATED CO_2 ON THE BEHAVIOR AND PHYSIOLOGY OF JUVENILE ROCKFISHES

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Introduction: Rapid increases in atmospheric [CO_2] have increased dissolved oceanic [CO_2] (pCO_2) and decreased seawater pH (Caldeira and Wickett, 2003). These chemical changes are known as ocean acidification (OA) and have strong negative effects on marine organisms (Kroeker, 2010). Vertebrates are predicted to be less susceptible to changes in pCO_2 and pH because they have well developed acid base compensatory mechanisms (Pörtner, 2005); however, in tropical fish species OA negatively affects both behavior and physiology leading to decreased fitness (Munday et al., 2009; Dixson et al., 2010; Ferrari et al., 2011; Allan et al., 2013). Our goals are to understand how OA will affect the behavior and physiology of juvenile rockfishes living in kelp forests within the highly dynamic California Current System (CCS). The CCS is characterized by strong seasonal and diurnal variability in pH due to upwelling and biological processes.

Methods:

- Captured and reared Copper (*Sebastes caurinus*) and Blue Rockfish (*S. mystinus*) for 2-3 months in 4 pH treatments: 8.0, 7.8, 7.5, 7.2
- Measured pH daily and carbonate chemistry weekly
- Tested:

1. Behavioral lateralization - Right vs. left brain dominance
2. Critical swimming speed (U_{crit}) - Swimming endurance
3. Aerobic scope – Difference in oxygen consumption between rest and maximum swimming speed

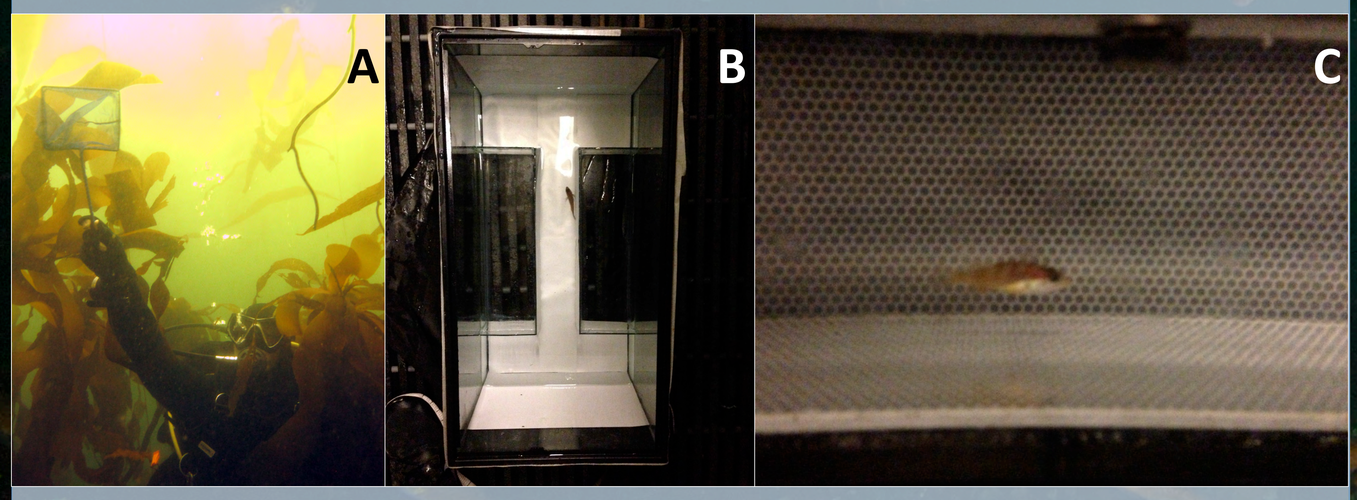

Fig 1. (a) Diver using hand net to catch juvenile rockfishes, (b) double T-maze for testing behavioral lateralization, and (c) juvenile Copper Rockfish in Loligo swim flume during critical swimming speed trial.

Results: OA affects Copper Rockfish behavior and physiology while Blue Rockfish are tolerant to OA

Chemistry Parameter	Control	Mid Century	End of Century	Extreme
Average Daily pH (±SE)	7.92 (±0.006)	7.79 (±0.006)	7.52 (±0.006)	7.33 (±0.009)
Average Weekly DIC (±SE)	2128.4 (±8.621)	2193.6 (±7.706)	2246.5 (±18.233)	2335.6 (±22.626)

Table 1. Measured daily pH and weekly Dissolved Organic Carbon (DIC) ± SE.

1. S. caurinus switch from being unbiased to left turn biased as pH decreases while *S. mystinus* do not change bias significantly
2. S. caurinus U_{crit} decreases with decreasing pH while *S. mystinus* U_{crit} is unaffected by changes in pH
3. S. caurinus aerobic scope decreases with decreasing pH while *S. mystinus* aerobic scope is unaffected

Sebastes caurinus

Sebastes mystinus

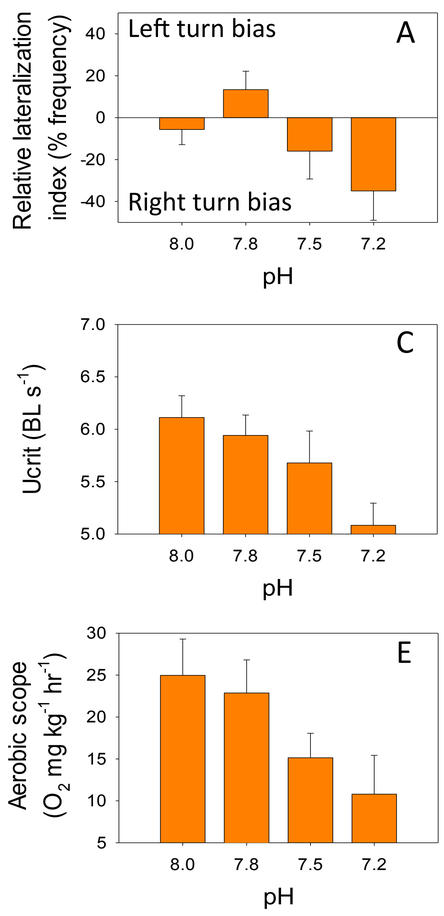

Fig 2. Effects of OA on the behavior and physiology of *S. caurinus* (orange bars) and *S. mystinus* (blue bars). Average relative behavior lateralization for Copper (a) and Blue Rockfish (b), average critical swimming speed (U_{crit}) of Copper (c) and Blue Rockfish (d), and average aerobic scope of Copper (e) and Blue Rockfish (f).

Conclusions

- *S. caurinus* have altered behavior and decreased physiological performance as pH decreases
- *S. mystinus* are tolerant to changes in pCO_2 and pH
- Species specific responses could lead to differential survival in the face of climate change (Munday et al., 2010; Allan et al., 2013)
- Differences in early life history may explain species specific responses

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